The atmosphere of Mars

Project by Stephen Bussard

Project Changes

Old Idea

MER Data
Get it, Clean it up, Format it

MER Profiles
Derive them, Verify them, Contribute them to PDS

Models
Compare profiles to model data and other profiles, Use data to tweak existing Thermodynamic models.

New Idea

MGS Data
Get it, Clean it up, Format it

MGS Profiles
Derive them, Verify them, Contribute them to PDS

MER Profiles
Get them from other sources

Models
Compare profiles to model data and other profiles, Use data to tweak existing Thermodynamic models.

Project History

The original plan of action for this project was to derive atmospheric profiles of Mars using data collected by the Mars Exploration Rovers, to compare newly derived profiles with profiles previously derived, to contribute the newly derived profiles to the Planetary Data System, and to study the Thermodynamics of the Martian atmosphere using newly derived profiles, previously derived profiles, and model predictions.

Unfortunately, I was not able to finish the derivations due to a lack of available ephemeris data. The focus of my project has changed from the actual derivations of the data to the use of previously derived data to study correlations between vertical dust distribution and thermodynamic properties of Mars at various times and seasons.

Main Objective

My hope is that the results of my work will aid and encourage in the development of Martian thermodynamic models by yielding reasonable and realistic expectations values of model parameters at various times and seasons, basing our information on detailed vehicle entry profile information.

Goals of this project

- To study the thermodynamic structure of the atmosphere of Mars by comparing data collected by the Mars Exploration Rovers, the Mars Global Surveyor and model predictions.
- To learn about seasonal variations in the Mars atmosphere.
- To attempt to provide information that will encourage the development of new and existing models of the atmosphere.

Progress

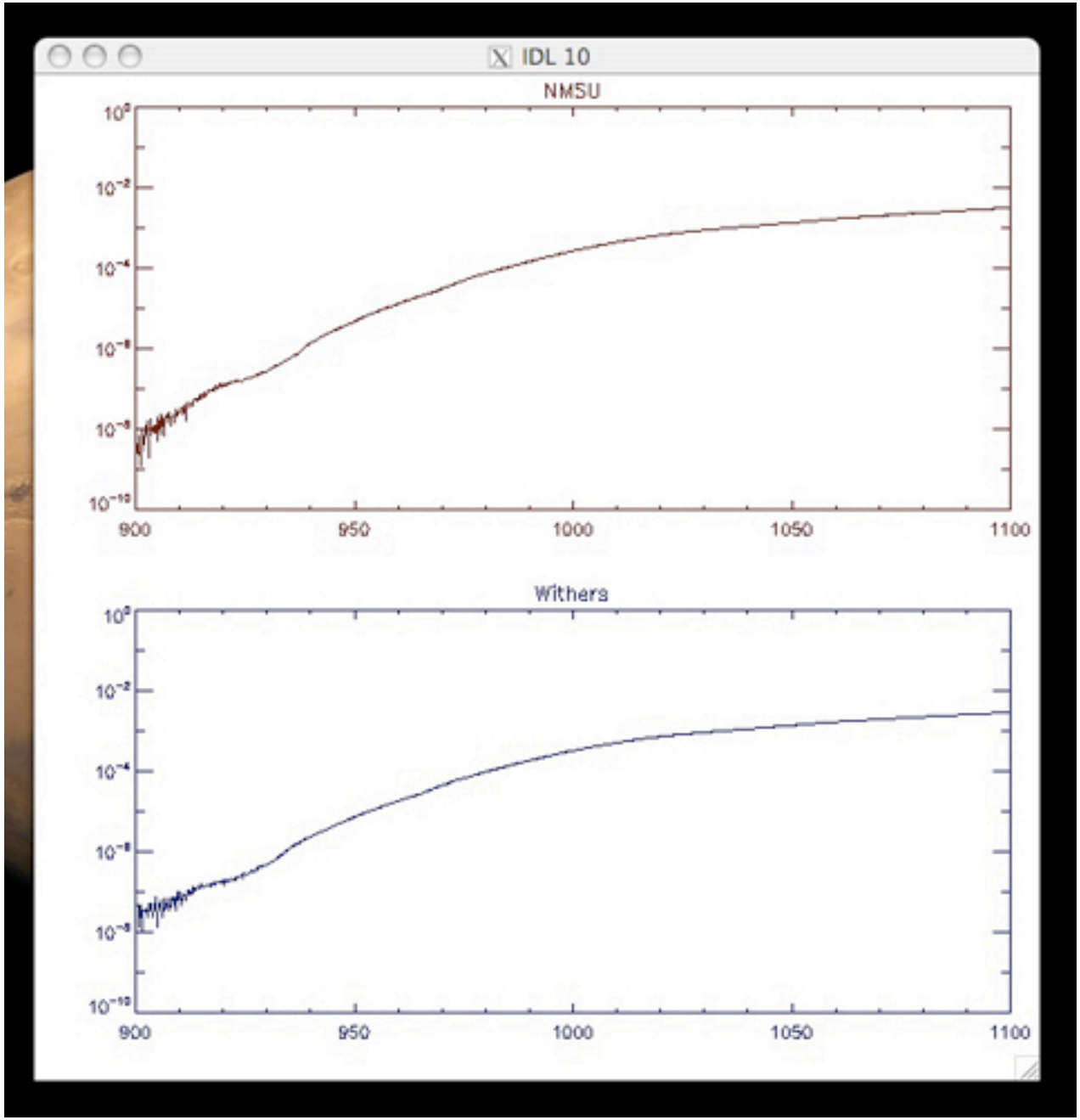
The derivation of a density profile for the atmosphere of Mars does not require trajectory reconstruction, so I did successfully derive a density profile for Mars using data from Opportunity.

During my time here I have also studied IDL (which I used to do research) and Java (which I used to build tools). I have made a client side tool for mirroring PDS data provided via apache web server directory listings. The tool works well, but there are still minor bugs.

The plots on the right are informal comparisons of the density of the Martian atmosphere with respect to time during the Entry, Descent, and Landing of Opportunity.

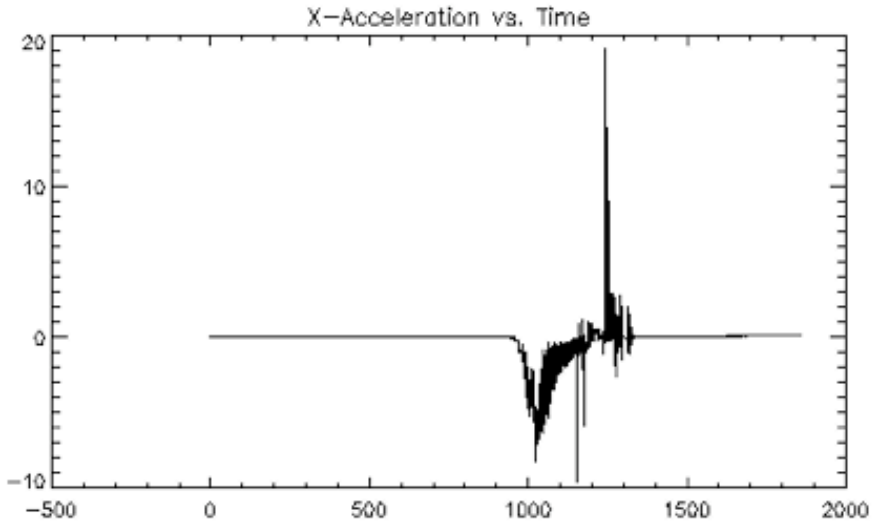
The vertical axes in both cases represent pressure (Pa), and the horizontal axes are time (s) since entry to the martian atmosphere.

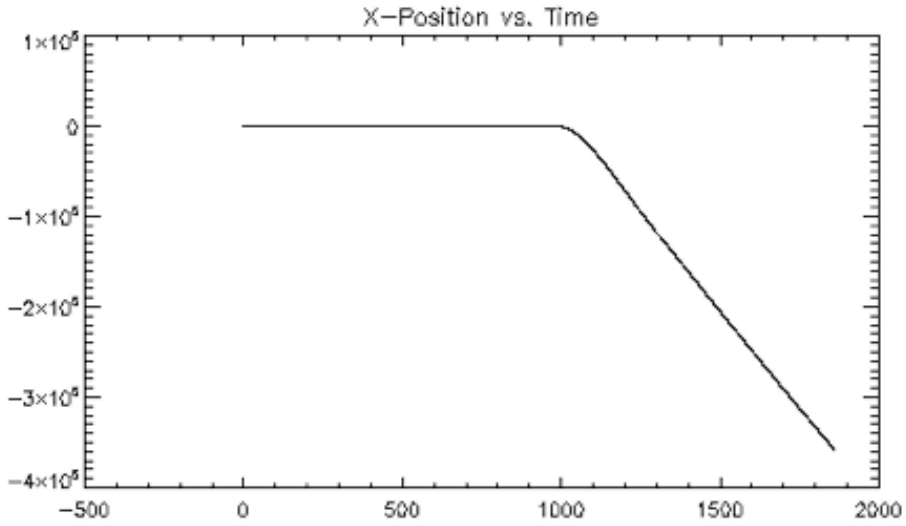
The top plot is our results, and the bottom is the result of Dr. Paul Withers.

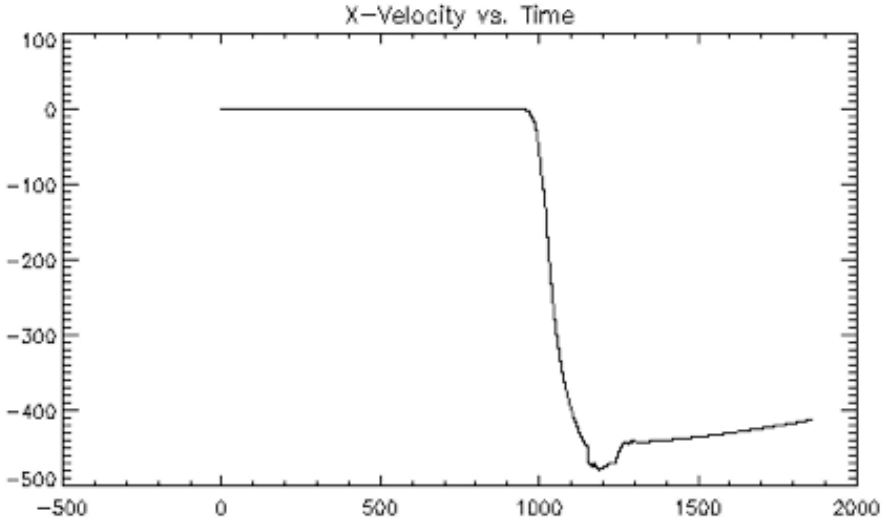


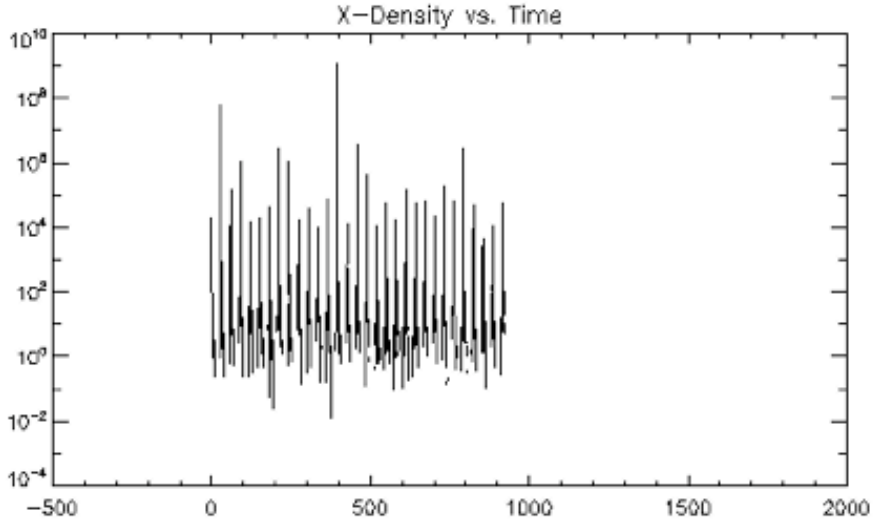
Sample plots

These are plots of data derived from Opportunity's IMU measurements
(Assuming no initial conditions)









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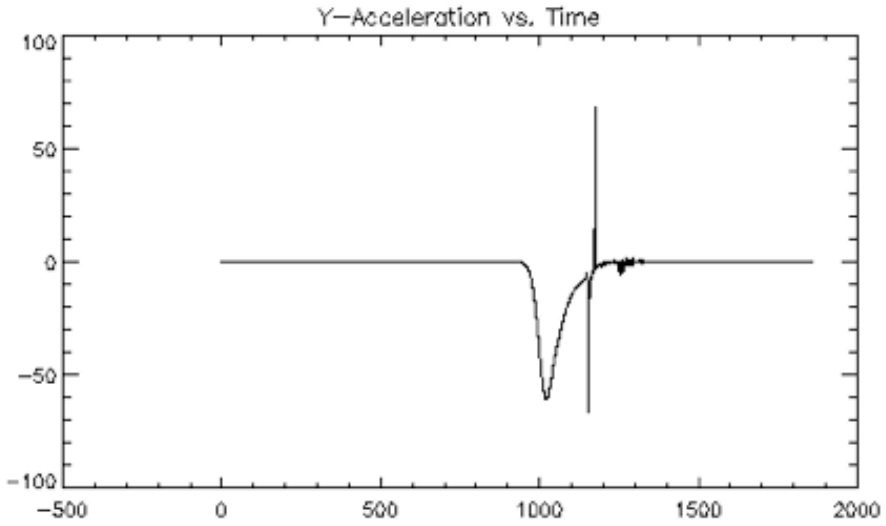

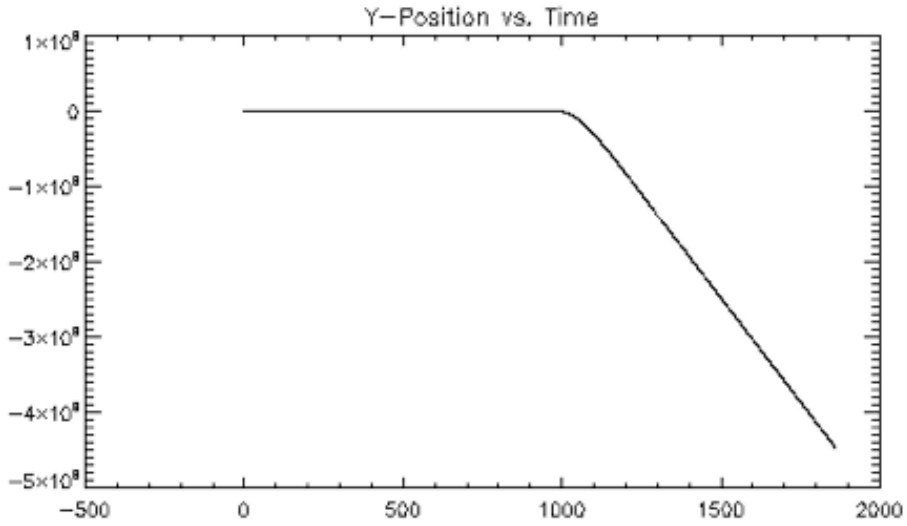

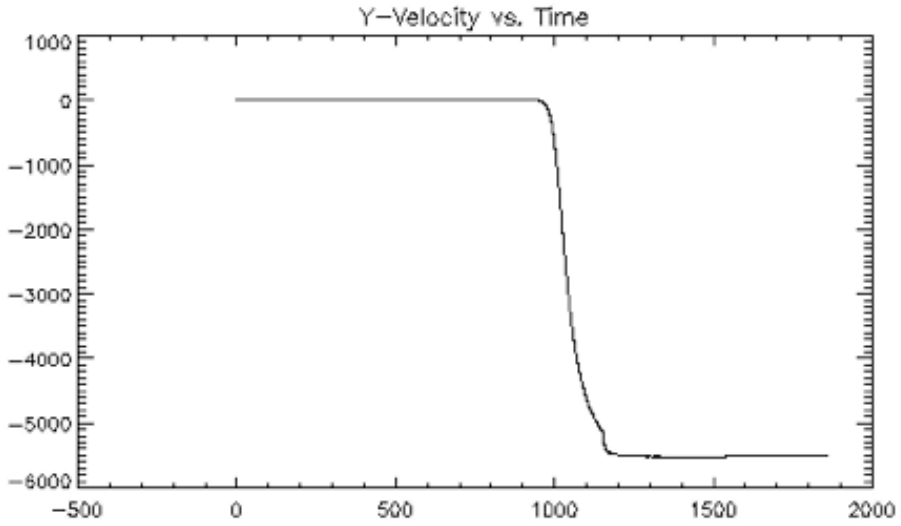

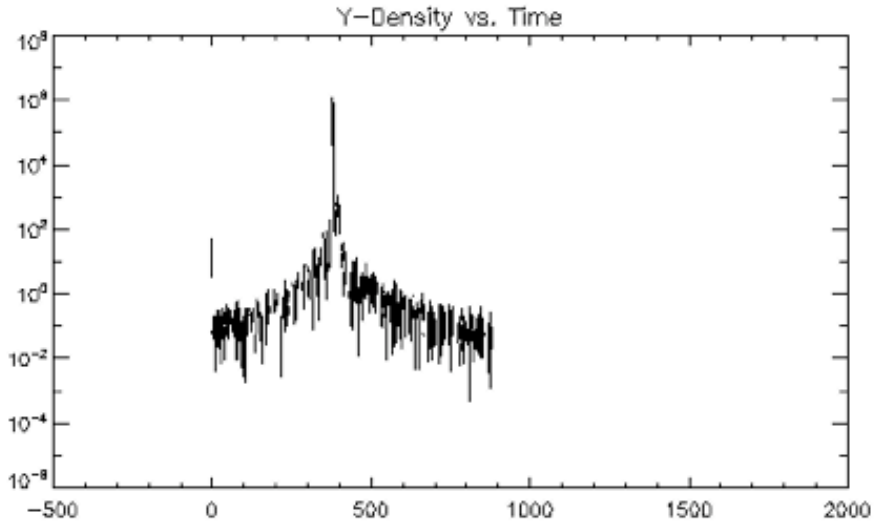

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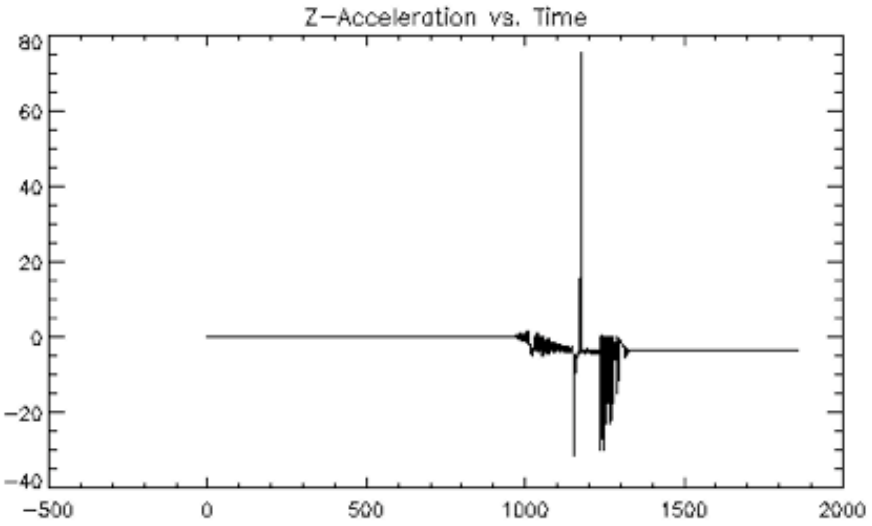

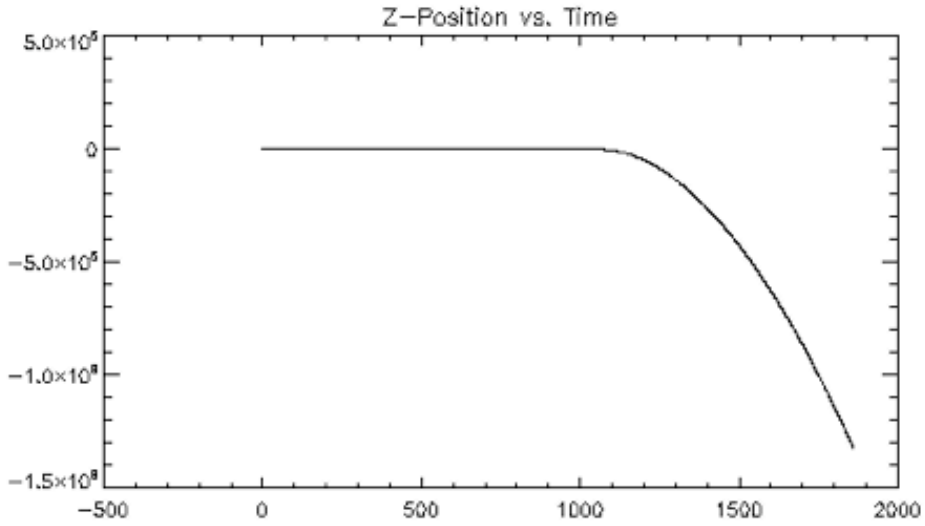

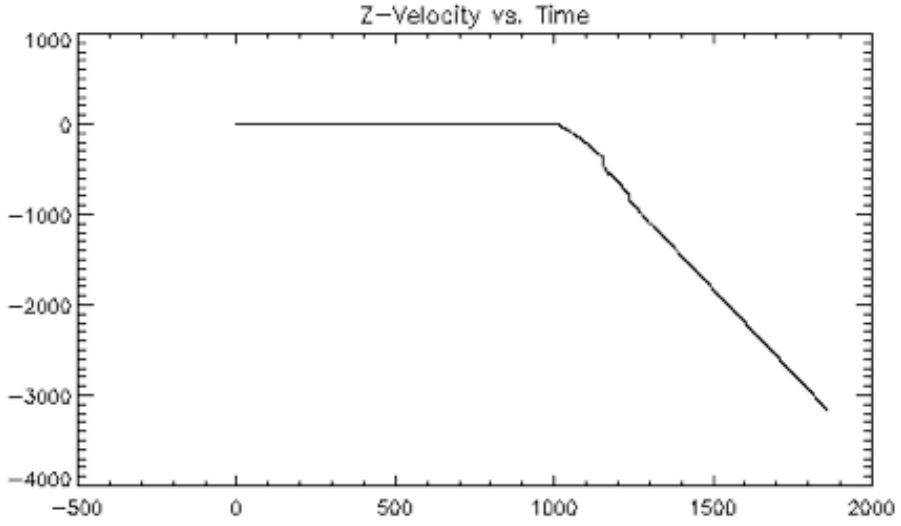

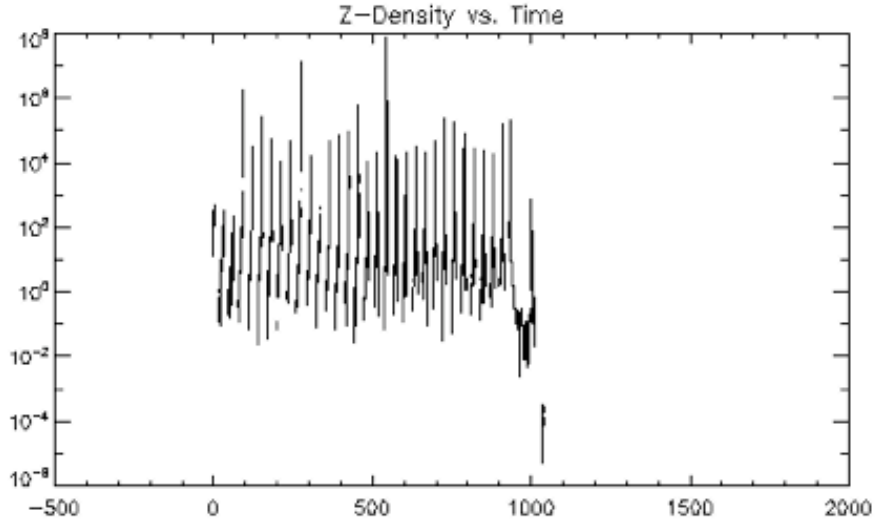

Mars Global Surveyor

The Mars Global Surveyor gathered information that could be used to derive atmospheric profiles at the same locations as the Mars Exploration Rovers at the same times that the Rovers landed. It is my plan to attempt to derive atmospheric profiles from Mars Global Surveyor data within the PDS.

Dust distribution

One method of determining the vertical dust distribution on Mars is to modify the dust input parameter of the model until the model mimics real data. Then it is reasonable to assume that the dust distribution is as the parameter suggests. I plan to investigate this and other methods of determining dust content and distribution.

Brief Reference List

Withers, P., Towner, M.C., Hathi, B., Zarnecki, J.C., 2003, Analysis of entry accelerometer data: A case study of Mars Pathfinder. Planet. Space Sci. 51, 541–561.

Withers, P., Smith, M.D., 2006, Atmospheric entry profiles from the Mars Exploration Rovers Spirit and Opportunity. Icarus 185, 133-142.